FIGURE VII

SUBJECT TRAINING ON TREADMILL WITH
SAFETY HARNESS, FRONT AND REAR VIEW

Calibration of the Apparatus

The load cell and the Honeywell Electronic System were calibrated by comparing the indicated deflections on the graphs with known weights added to the load cell. Linearity of the load cell measurements was confirmed. This calibration procedure was carried out previous to both pre and post-test periods. During both testing periods a calibration check was made at regular intervals.

Statistical Treatment

The significance of the differences between pre and post-test group means of each variable in each test set was computed using the analysis of covariance technique (4). The analysis of covariance was done via the IBM 360 computer at the University of Alberta.

To determine what set of variables was most strongly related to 100 meter sprint time a stepwise multiple regression analyses on the pre minus post-test data set was also calculated utilizing the IBM 360 computer system at the University of Manitoba. The dependent variable was 100 meter sprint time and the independent variables were the eight physiological parameters under investigation. A correlation matrix was also determined for each of the pre, the post and the pre minus post-test data sets.

One-tailed T-tests were computed on each variable to determine if any statistically significant pre and post differences within groups existed.

Differences at the 0.05 level were considered to be significant in each analysis.

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CHAPTER IV

RESULTS AND DISCUSSION

Results

The pre and post-test means are shown for each variable for each group in Table I.

The data were treated with an analysis of covariance technique to determine if any significant differences between groups occurred at the post-test when corrections were made for any sampling differences at pre-test time. The results are shown in Table II.

To determine if statistically significant differences existed between pre and post scores within groups, one-tailed t-test computations were made (df=7, $t_{\alpha<0.05} = 1.895$), Appendix B. All groups were found to have significant differences between pre and post-test mean 100 meter times. Mean concentric leg strength was found to decrease significantly from pre to post-test time in the high-speed treadmill group.

Mean reaction time scores increased significantly from pre to post in all the control and track training groups. The significant intragroup values are denoted in Table I.

TABLE I

PRE AND POST-TEST MEANS AND DIFFERENCES

	CONTROL GROUP			TRACK TRAINING GROUP			HIGH SPEED TREADMILL TRAINING GROUP		
	Pre	Post	Post minus pre	Pre	Post	Post minus pre	Pre	Post	Post minus pre
SVJ	20.1875	20.4375	0.2460	19.6250	19.9687	0.3437	19.5749	19.7812	0.2062
SLJ	94.4375	95.1875	0.7500	89.8750	89.1875	-0.6875	88.1875	88.5625	0.3750
100m	12.9999	12.8724	-0.1275*	12.8474	12.6649	-0.1825*	12.6524	12.3349	-0.3175*
HF	93.7500	95.1250	1.3750	93.1250	90.8750	-2.2500	99.5000	96.0000	3.5000
HE	31.1250	33.7500	2.6250	34.5000	36.3750	1.8750	31.7500	33.8750	2.1250
CLS	1008.7500	962.5000	46.2500	770.0000	724.3750	-45.6250	903.7500	679.3750	-224.3850*
ELS	1157.5000	1197.5000	40.0000	1111.2500	1064.3750	-46.8750	1112.5000	1065.6250	-46.8750
ILS	937.3750	1063.1250	128.7500	955.0000	903.7500	-51.2500	950.0000	854.3750	-95.6250
RT	0.1241	0.1503	0.0262*	0.1044	0.1297	0.0252*	0.1297	0.1288	-.0008

*denotes values greater than the t-critical (α=0.05), (df=7) for pre-test and post-test differences within groups.

TABLE II

ADJUSTED POST-TEST MEANS

VARIABLE	CONTROL GROUP	TRACK TRAINING GROUP	HIGH SPEED TREADMILL TRAINING GROUP	SIGNIFICANT CHANGES BETWEEN GROUPS
SVJ	20.093918	20.118591	19.974945	NO
SLJ	91.746704	90.102371	91.088379	NO
100 m	12.722555	12.652244	12.497666	NO
HF	96.965820	93.389297	91.644836	NO
HE	34.562607	35.130661	34.306702	NO
CLS	896.36694	796.03882	673.84375	NO
ELS	1177.4358	1074.8191	1075.2446	NO
ILS	1072.1416	897.37598	851.73193	NO
RT	.15038264	.12972486	.12889206	

Maximum Oxygen Uptake

There was no significant change in the maximum oxygen uptake between the pre and post scores within the three groups, (Table III). Further, there were no significant changes found in-between group comparisons, (Table III). The control group mean maximum oxygen uptake decreased by 2 ml./kg./min. The track and treadmill training groups demonstrated mean increases of 1.96 and 1.56 ml./kg./min. respectively.

Body Weight

There was no significant change in subjects' body weight following the seven week study period, (Tables III and IV). The control, track and treadmill groups experienced nonsignificant mean increases in body weight of 0.5, 0.4 and 0.06 pounds respectively.

Subjects' Injury Record

Prior to the pre-test all subjects reportedly were healthy individuals without any complaints of muscle or joint stiffness or soreness. During the seven week investigation, 45 complaints of muscle and joint stiffness and soreness were registered, (Table V). The control group recorded 3 complaints and the track group recorded 10 during the first four weeks. The treadmill training group recorded 32 muscle-joint complaints. The inter and intra-group differences were statistically significant at the 0.05 level

TABLE III

MAXIMUM OXYGEN UPTAKE AND BODY WEIGHT CHANGES

SUBJECTS	POST MINUS PRE VALUES IN ml./kg./min O_2 UPTAKE	POST MINUS PRE VALUES IN POUNDS BDY. WT.
Control Group		
1	-2.32	3.5
2	-2.34	1.0
3	-1.55	-3.0
4	-1.48	.5
5	-2.84	-3.0
6	4.13	2.5
7	- .37	1.0
8	-6.22	2.0
Track Training Group		
1	1.14	-5.0
2	-2.12	5.0
3	.30	-2.0
4	6.44	-4.0
5	-1.43	2.0
6	- .04	2.5
7	11.66	1.5
8	- .23	-6.5
High Speed Treadmill Training Group		
1	-1.26	-2.5
2	-1.64	-3.0
3	1.03	3.0
4	3.93	.5
5	3.88	-1.0
6	1.04	.5
7	.61	-2.0
8	4.93	5.0

TABLE IV

SUBJECTS PERSONAL DATA

	AGE (years)	HEIGHT (inches)	PREWEIGHT (pounds)	POSTWEIGHT (pounds)	MAJOR ACTIVITY
Control Group					
1	24	68	150	153.50	Gymnastics, jogging for personal fitness
2	22	73	167	167	Racket ball
3	19	69	165	162.25	Gymnastics, jogging for personal fitness
4	20	67.50	145	145.50	Sprinting and long jumping
5	29	66.50	155	152	Personal fitness, jogging & weight training
6	25	68	135	137.50	Distance running
7	21	67	148	149	Gymnastics
8	21	75	164	166	Distance running
Mean	22.62	69.25	153.62	154.09	
Range	19-29	66.5-75	135-167	137.5-167	
S.D.	3.04	2.87	10.51	9.71	
Track Group					
1	31	74	197	192	Decathlon
2	29	75.50	178	183	Cross country skiing and jogging
3	25	74	166	164	Distance running
4	20	73	141	137	Hurdles
5	20	72	133	135	Sprints
6	17	67	148	150.50	Middle distance and football
7	24	74	185	186.50	Hurdles and comtemporary dance
8	33	72	196	189.50	Sprints, middle distance, basketball
Mean	24.87	72.68	168	167.18	
Range	17-33	67-75.5	133-197	135-192	
S.D.	5.37	2.41	23.37	22.28	
Speed Treadmill					
1	26	73	166	168.75	Sprints, long jump
2	25	71.75	147	144	Middle distance runner
3	22	71.50	173	176	Decathlon
4	18	69	127.50	128	Sprints
5	24	70.50	150	149	Personal fitness, jogging & boxing
6	19	70	139.50	140	Speed skating & jogging
7	20	70	152	150	Long jump
8	17	68.50	152	157	Cyclist & jogging
Mean	21.37	70.53	150.87	151.59	
Range	17-26	68.5-73	127.5-173	128-176	
S.D.	3.66	1.40	13.28	14.46	

TABLE V

MUSCLE-JOINT SENSATIONS

	COMPLAINTS	NO. OF COMPLAINTS
Control Group		3
1	stiff from camping and hiking trip	
2	nil	
3	blisters	
4	nil	
5	nil	
6	heel bruise	
7	nil	
8	nil	
Track Training Group	(no complaints after 4 weeks training)	10
1	sore groin, stiff quadricep	
2	sore feet, stiff quadriceps	
3	stiff quadricep	
4	stiff quadricep	
5	shin splints	
6	slightly sprained ankle	
7	stiff quadriceps	
8	stiff quadriceps	
High Speed Treadmill Training Group	(complaints throughout 7-week period)	32
1	tight hamstrings, stiff hamstrings, tired	
2	back of knees tight, stiff calves, stiff quadriceps, tired, outside of rt. knee sore	
3	tight calves, tight hamstrings, left knee sore, left ankle sore	
4	tight calves, sore hamstrings, stiff hamstrings, tight hamstrings, rt. hamstring sore	
5	back of legs tight, tight hamstrings, rt. knee sore, sore left side, sore outside rt. knee	
6	back of legs tight, stiff hamstrings, tired	
7	tight calves, stiff calves, sore rt. ankle, rt. calf sore	
8	back of legs tight, rt. knee sore, tired, left calf stiff	

A multiple stepwise regression analysis, (Table IX), resulted in no statistically significant relationships evident between 100 meter sprint performance and other parameters.

Other Analysis

Simple correlation matrices were computed for the pre, the post and the pre and post-test differences, (Tables VI, VII and VIII).

The pre-training correlation coefficients revealed that Sargent vertical jump (SVJ) was significantly correlated with standing long Jump (SLJ), 100 meter performance (100 m.), hip flexion (HF), hip extension (HE) and isometric leg strength (ILS). The standing long jump significantly correlated with Sargent Jump, hip flexion and the three measures of leg strength. 100 meter performance was found to have statistically significant correlations with Sargent Jump, and hip flexion.

The measure of hip flexion possessed a statistically significant correlation with Sargent jump, standing long jump, 100 meter performance, hip extension and isometric leg strength.

Hip extension correlated significantly with Sargent Jump and hip flexion.

Concentric leg strength displayed a statistically significant correlation with standing long jump, eccentric leg strength (ELS) and isometric leg strength (ILS).

Eccentric leg strength significantly correlated with

Sargeant jump and the other two measures of leg strength.

Isometric leg strength analysis revealed statistically significant correlations with both measures of power (SLJ, SVJ), hip flexion, and concentric and eccentric leg strength. Table VI denotes values greater than the t-critical (α=0.05, df=23) for pre-training test results.

Reaction time did not demonstrate any statistically significant correlation coefficients.

Table VII portrays the correlation coefficients for the post-training test values.

Sargent jump displayed a significant correlation with standing long jump and 100 meter performance. The significant correlation that existed with hip extension and isometric leg strength was not demonstrated at post-test.

Standing long jump demonstrated a statistically significant correlation with Sargeant Jump, 100 meter performance (not in existence at pre-training test time), hip flexion and concentric leg strength. The significant correlation between standing long jump and eccentric and isometric leg strength that was demonstrated at pre-training test time was not present at post-training test time.

100 meter performance at post-training test time displayed a significant correlation with Sargeant jump, standing long jump and hip flexion.

Hip flexion demonstrated statistically significant correlation

with both measures of power (SVJ and SLJ) and 100 meter performance. The correlation with hip extension and isometric leg strength was lost at post-training test time.

At post-test hip extension did not display significant correlations with any of the parameters under study.

Concentric and eccentric leg strength demonstrated statistically significant correlations with standing long jump.

The three measures of strength correlated significantly with each other at post-test. Isometric leg strength lost its correlation with the two measures of power (SVJ and SLJ) and hip flexion after training.

A correlation coefficient matrix using pre and post test differences, (Table VIII) demonstrated the following statistically significant correlations:

(a) Hip flexion and hip extension

(b) Eccentric leg strength and hip flexion

(c) Eccentric and isometric leg strengths.

TABLE VI

PRE-TRAINING CORRELATION COEFFICIENTS

PARAMETERS		SVJ	SLJ	100 m	HF	HE	CLS	ELS	ILS
		1	2	3	4	5	6	7	8
SLJ	2	0.825*							
100 m	3	-0.630*	-0.386						
HF	4	0.565*	0.647*	-0.481*					
HE	5	0.427*	0.392	-0.238	0.570*				
CLS	6	0.321	0.467*	0.005	0.232	-0.015			
ELS	7	0.360	0.522*	-0.115	0.239	0.186	0.747*		
ILS	8	0.534*	0.648*	-0.306	0.423*	0.194	0.838*	0.830*	
RT	9	0.069	0.230	0.104	0.275	0.244	-0.027	-0.122	-0.001

*denotes values greater than the t critical (0.396, α =0.05, df=23) for pre-training test results

TABLE VII

POST-TRAINING CORRELATIONS COEFFICIENTS

PARAMETERS		SVJ	SLJ	100 m	HF	HE	CLS	ELS	ILS
		1	2	3	4	5	6	7	8
SLJ	2	0.755*							
100 m	3	-0.550*	-0.411*						
HF	4	0.484*	0.533*	-0.529*					
HE	5	0.180	0.069	-0.159	0.248				
CLS	6	0.372	0.586*	-0.195	0.253	-0.115			
ELS	7	0.365	0.277	-0.090	-0.037	-0.070	0.670*		
ILS	8	0.367	0.326	-0.265	0.194	-0.008	0.658*	0.632*	
RT	9	-0.011	-0.161	-0.071	0.131	-0.139	0.227	0.248	0.279

*denotes values greater than the t critical (0.396, α=0.05, df=23) for post-training test results

TABLE VIII

CORRELATION MATRIX POST MINUS PRE-TEST VALUES

PARAMETERS	SVJ	SLJ	100 m	HF	HE	CLS	ELS	ILS	RT
SVJ	1.00000	0.07198	0.13711	0.23168	0.28387	0.07435	0.09170	0.16593	0.01145
SLJ	0.07198	1.00000	0.10130	-0.18070	0.14764	0.17829	-0.15893	0.16556	-0.10921
100 m	-0.13711	0.10130	1.00000	0.17884	0.12906	0.03618	-0.00195	0.06797	0.09775
HF	-0.23168	-0.18070	0.17884	1.00000	0.45217*	0.10315	0.50221*	0.28945	0.05925
HE	-0.28387	0.14764	0.12906	0.45217*	1.00000	-0.13437	0.18818	0.24239	0.00037
CLS	0.07435	0.17829	0.03618	0.10315	-0.13437	1.00000	0.30634	0.33872	-0.03780
ELS	0.09170	-0.15893	-0.00195	0.50221*	0.18818	0.30634	1.00000	0.68270*	0.03742
ILS	0.16593	0.16556	0.06797	0.28945	0.24239	0.33872	0.68270*	1.00000	0.28906
RT	-0.01145	-0.10921	0.09775	0.05925	0.00037	-0.03780	0.03742	0.28906	1.00000

*denotes values greater than the t-critical (0.396, α=0.05, df=23) for post minus pre test values

TABLE IX

MULTIPLE STEPWISE REGRESSION ANALYSIS

(Critical $t_{24.3}^{.05} = 1.725$)

VARIABLE NUMBER	REGRESSION COEFFICIENT	STD. ERROR OF REG. COEFF.	COMPUTED T-VALUE
4	0.00676	0.01002	0.674
2	0.00971	0.02340	0.415
1	-0.02594	0.07681	-0.338
9	0.78429	2.58031	0.304
7	-0.00012	0.00037	-0.325
8	0.00006	0.00043	0.142
6	0.00002	0.00031	0.080
5	-0.00011	0.01211	-0.009
INTERCEPT	-0.20603		

FOF 8 Variables Entered

Multiple Correlation Coefficient	0.280
(Adjusted for D. F.)	0.570
F-Value for Analysis of Variance	0.160
Standard Error of Estimate	0.308
(Adjusted for D. F.)	0.369

DISCUSSION

While attempting to recruit subjects for this study it was evident that good sprinters were apprehensive about volunteering to participate. Because high-speed treadmill training was a relatively new approach to sprint training many sprinters were in fear of jeopardizing their chances for improving their performance. Several stated that they would participate only if they were randomly selected to represent the control or track training group. As a result two of the best sprinters dropped out after the pre-training tests.

Pre-training Analysis

A summary of the results of the pre-training tests on all original subjects reinforces previous findings in the review of literature. When all measures are ranked and compared (Appendix A), it is evident that the best sprinter on the average, was the most physically fit, the tallest, the heaviest, the strongest, the most powerful and possessed more hip flexibility than the poorer sprinter. Reaction time, however, was on the average similar for all the subjects. Irwin (37), using the subjects in this study, analyzed stride rate and stride length at pre, mid and post-training periods, and was able to determine that on the average the best sprinters possessed the longest stride length. Stride rate, however, was similar for both groups.

It was interesting to note that both stride rate and reaction time were on the average similar for all subjects. These two measures would in theory appear to reinforce each other since both have been related to neuromuscular control by several researchers (8, 45, 73, 81).

Computation of correlation coefficients using pre-training test scores for all subjects revealed that reaction time was not correlated with any of the parameters studied. This finding was in disagreement with research by Scripture (69), Hipple (27), Wilson (82), Westerlund and Tuttle (81), Younger (85), Pierson and Rasch (59), Kerr (41, 42) and studies in Munich (67). However the results of the analysis in this study strongly agreed with Henry (29), Slater-Hammel (74) and others (12, 21, 28, 30, 31, 33, 34, 40, 44, 47, 52, 58, 61, 70, 72, 76). These researchers failed to find statistically significant correlation coefficients when simple reaction time was compared to other physiological parameters and sprint performance after training.

Johnson and Nelson (38) have attempted to explain why insignificant relationships exist. They stated:

> . . . . It has been fairly well established that some individuals react quickly but move slowly; and some react slowly but are able to run or move very rapidly once they get started.
>
> . . . when speed of movement and reaction time are to be studied separately, the specificity of each must be considered, as well as how each may operate in relation to the movements involved and the task. In other words it would not make much sense to measure reaction time by having the subject release a telegraph key device upon hearing a buzzer, and speed of movement by the 100 yard dash, and then attempt to make conclusions regarding the reaction and movement speed of a defensive lineman in football. The tasks are too unrelated.

This investigation measured simple reaction time by using the leg and muscle groups that were specifically involved in the sprint start (back leg; leg extension muscles). Final analysis revealed no significant correlation although Johnson's and Nelson's (38) advice was followed. Since adherence to specificity did not demonstrate a

significant correlation it is reasonable to conclude that reaction time is not an important component in the make up of a good sprinter.

The relationship between 100 meter performance, strength, power and stride length, in the present study, are supported by other findings (15, 16). Strength, by definition, is a component of power. Only isometric strength demonstrated a significant correlation coefficient with the Sargent jump, (Table VI). However all three measurements of strength were found to be significantly correlated with standing long jump. 100 meter performance on the other hand, displayed a statistically signficiant correlation coefficient with standing vertical jump but not with any of the three measures of strength. This power-strength -- 100 meter performance relationship suggests that the Sargent jump is more important than the strength measures or the standing long jump as a predictor of 100 meter performance. This deduction is supported by two studies which found static strength (5, 20) and dynamic strength (5, 49) significantly related to leg power, thus indicating strength as an important variable in power measurement. Also several studies (9, 14) have indicated that speed was significantly related to power and that it was more important than strength in athletic performance. Additional support is evidenced when McCloy (50) found the Sargent jump was significantly related to the total point score of select track (including sprinting) and field events.

Dyson (19) states, ". . . stride length is the product of a driving forward of the entire body." Since the best sprinters possessed more strength and power they were able to "push-off" more

forcefully against the ground and therefore displayed a longer stride pattern. A characteristically longer stride results in a greater range of movement in the hip joint and therefore the fastest sprinters also displayed more hip flexion. The fact that 100 meter sprint performance, leg power and hip flexion demonstrated statistically significant correlation coefficients supports this theory. This was evident in all analyses (Tables VI, VII, VIII and IX).

This analysis should have practical applications in training of sprinters. Many drills have been suggested by coaches (6, 62, 83) to improve stride length. In all cases these drills attempt to have the runner consciously lengthen his stride while sprinting. The analysis of the data in this study and others (6, 15, 18, 22, 62, 83) would suggest that more emphasis should be placed on leg power so that a greater "push off" could be produced resulting in a lengthened stride. This is only true if the stride rate remains constant. If runners have low levels of flexibility in the hip joint the stride length could possibly be restricted until this quality was improved.

Pre and Post-Test Differences Analysis

A minimum maximum oxygen uptake of 45 ml./kg./min. was the criterion for acceptance of subjects into this study. This was necessary so that any changes in performance would not be due to physical conditioning and so that a conditioning phase was not

necessary at the beginning of the project. This minimum requirement was also necessary to ensure that the subjects were physically fit enough to withstand the physiological stress if they were randomly selected to represent either of the training groups. According to Balke's classification of fitness, which is based on max VO_2 (ml./kg./min.), the subjects were in "good" cardiovascular condition at the time of the initial test and could be considered being in a trained state (2).

The pre-test mean maximum oxygen uptake of the twenty four subjects was 54.92 ml./kg./min., (Appendix A). This value is similar to the maximum oxygen uptake of Olympic sprinters during the XVIIth Olympic Games in Rome in 1960. De Prampero et al (17) calculated their mean maximum oxygen uptake to be 55.50 ml./kg./min.

As expected there was no statistically significant change in the maximum oxygen uptake values between the pre and post periods. All subjects were instructed to continue with their normal everyday pattern of activity. The two training groups did additional training as outlined in Chapter III. The fact that the pre minus post MVO_2 only changed .44 ml./kg./min. meant that the subjects did carry on normally as instructed. Several investigators have studied the changes following cessation of training and found, in general, a rapid return to pre-training levels when activity is terminated (24, 53, 64, 65, 66, 79, 80). There was no detraining effect evident in this study including the control group.

The pre minus post mean difference in body weight for the twenty-four subjects was 0.5 pounds. This value strengthened the suggestion that the subjects did not change their normal diet and or exercise pattern during the seven weeks.

"Stress is the state manifested by the specific syndrome which consists of all the non-specifically induced changes within a biologic system" (70:52). Simply stated, stress is the rate of wear and tear in the body which would include being tired, jittery, weak muscle sensation, or ill. These are known as subjective sensations of stress. The stress changes include damage and adaptive reactions which include mechanisms of defense set up by the body to combat stress. This stress syndrome, as it is know, is defined as the "totality of changes" (70:55). Forty-five muscle-joint complaints were recorded during the course of this study, (Table V). The control group reported three complaints which can only be explained as normal incidentals, not symptoms of training stress. The track and high-speed treadmill training groups registered 10 and 32 complaints respectively. These complaints must be considered as subjective sensations of stress (70:52). Complaints by the track training group were non-existent after four weeks of training whereas the treadmill group registered complaints throughout the seven week period, although fewer during the last two weeks.

This would suggest that physiological stress was present throughout the seven weeks in treadmill training. This would also suggest that adaptation to stress was still continuing at the end

of this study whereas the track training group had complete adaptation after the fourth week. A logical conclusion would be that high speed treadmill training is a form of overload sprint training. The flat-track training could have reached a plateau and another form of 100 meter sprint training stress would be required as further stimulus. This was somewhat in evidence when 100 meter sprint performance improvement was less in track than in the treadmill group (Table I). No difference in sprint performance was demonstrated by the track group after the fourth week (37). Coaches who have realized that flat-track sprint training does eventually limit improvement have experimented with various methods of forced running. Athletes have attempted running downhill (16, 48, 56) running behind cars, motorcycles, trains (16, 46, 48, 56) and a variety of resistance running methods (16, 57).

The track training group registered six stress sensations in the quadriceps muscle group. The treadmill group registered only one such complaint. However, fifteen hamstring and back of the legs stress sensations were experienced by the treadmill group. This is clearly a definite significant difference in stress and suggests that a different technique was required to run on the treadmill. Similar views were expressed by Nelson et al (55) and by Dintiman (16). Furthermore, there was a general advancing pattern of stress sensation in the treadmill group as recorded by five of the eight subjects. A stress sensation was first experienced in the calf muscle, then the hamstring group and finally the knee joint. This pattern again

suggests that a possible change in running technique was occurring during the seven weeks. In conversations with the subjects during the study they reportedly were not conscious of trying to run with different technique. Their immediate objective was "to keep up with the treadmill." Constant personal observations by the investigator revealed that the treadbelt was throwing the leg backward so that maximum knee flexion was occurring, in many instances heels touching buttocks. This resulted in a shortened radius and resultant increased velocity (7:331) of the leg coming through (recovery) to a final extension before being placed on the treadbelt to complete the stride cycle. If this happened, the knee was actually hyper extended before the foot touched the treadbelt. This hyper extension and resultant hamstring activity would explain the hamstring and knee joint sensations of stress.

This hyper extension does not occur while running on a flat track because the lower leg does not have the momentum that results from the rapid stride recovery on the treadmill.

The fact that the flat track group experienced stress sensations in the quadriceps implies that they were pushing against the ground as they ran. This is the action (extension of the leg) of the quadriceps group of muscles and is the required technique for running on a flat track unaided (19). The treadmill group obviously was unable to push against the treadbelt because they could not apply force fast enough. Their action was simply to lift their legs and set them down rapidly in succession. This leads the writer

to conclude that this knowledge could be utilized to determine whether subjects were ready to experience an increase in treadbelt speed during training. If a subject was experiencing quadriceps stress sensation or a feeling of pushing this could be an indication of adaptation to the existing treadbelt speed. The speed should then immediately be increased and adoption to a new plateau advanced. This would be a monotered scientific approach to observing the overload principal of training. Only the treadmill group recorded sensations of being tired; four were recorded. This strengthens the suggestion that the treadmill training was physiologically much more stressful.

Dintiman (16) did not experience complaints of injury or discomfort during the high-speed workout by his subjects. He credits this record to his warm-up which consisted of the following drills executed by running in place:

1/2 speed (low knee lift) -- 2 repetitions of 30 seconds each

1/2 speed (high knee lift) -- 2 repetitions of 30 seconds each

3/4 speed (high knee lift) -- 2 repetitions of 15 seconds each

7/8 speed (high knee lift) -- 2 repetitions of 8-10 seconds each

Maximum speed (high lift) -- 2 repetitions of 5-8 seconds each.

Dintiman reported that: "no complaints of injury or discomfort during the high-speed workouts". Most of the complaints were voiced before the warm-up when subjects were questionned upon arrival at the laboratory. Other probable explanations for this difference in stress

sensations between these two studies might be accounted for by the fact that Dintiman allowed more rest between sprints and between workouts.

Intra and inter-group pre and post-test differences were not statistically significant for both measures of power. Similar results were observed by others (23, 25, 63) who found insignificant differences between groups in power measures after training to improve sprint performance.

Multiple stepwise regression analyses demonstrated low positive statistically insignificant relationships between 100 meter sprint performance and power as measured in this study.

Analyses of correlation coefficients (Tables VI, VII) and Rank Order analysis, (Appendix A) associate power with flexibility, strength and 100 meter performance. This association was very evident in the pre-test analysis and in other investigations (16, 15). These correlations further demonstrate the complex interrelationships that have been evidenced by researchers in the past. Since the better sprinters are more powerful and have more strength and flexibility (Appendix A) it is obvious that it is desirable to improve the level of these physiological parameters in training sprinters.

Analysis of covariance revealed no statistically significant differences between groups in 100 meter sprint performance after training. Since no other research has been undertaken to compare flat track and high speed treadmill training upon physiological parameters this initial investigation can be used for guide and

comparison purposes. The pre minus post within group differences were statistically significant at the 0.05 level of confidence, (Table I). High speed treadmill training did improve 100 meter sprint performance by 0.31 seconds. This improvement is more than the improvement in the 100 sprint performance world record during the last fifty years (39). This 0.31 second improvement was more than the 0.18 second improvement by the flat track group despite the fact that the treadmill group had a mean 100 meter performance time which was better than the control and track group (Table I).

The fact that the treadmill group improved their sprint performance significantly substantiates findings by Dintiman (15). Dintiman observed a mean improvement of 0.20 seconds for the high speed treadmill group yielding a t-value of 4.9 which was significant at the 0.05 level of confidence.

Analysis of covariance determined no statistically significant differences between groups occurring at post-test time in hip flexibility. The treadmill group displayed a trend of a low positive improvement in both hip flexion and extension (Table I), which in total was greater than the combined flexibility (flexion and extension) of the control and flat track groups. This difference was not statistically significant and agrees with observations which were made by Nelson (54) when he studied the effects of increased flexibility upon sprinting speed. Change in flexion did not necessarily parallel an equal change in extension. This has been positively demonstrated by Harris (26) who performed a factor

analysis on flexibility studies and found that each possible joint action was uncorrelated to any other joint action and by Dickinson (13) who observed low correlations of joint movements; that the different movements possible at a joint are independent of each other. The mean values obtained from the three tests of strength executed in this study, generally agree with those reported in the literature.

There was no statistically significant difference between groups at post-test time in the three measures of leg strength, (Table I). The control group had low positive improvements in leg strength which could be accounted for by the fact that the pre-test occurred at the end of spring and the post-test was administered in late summer. During the summer people tend to be more active than in the winter and therefore leg strength should improve during the spring and summer months. The improvement could still be occurring at pre-test time. This could also partially explain the reason the control group displayed a trend of low improvement in the power measures, (Table I).

Both training groups displayed decrements in strength measures during the seven week program. This decrease in concentric strength between the pre and post-tests of the treadmill group was statistically significant at the 0.05 level of confidence. These observations were similar to others (10, 11, 32, 43, 51, 60, 73) who found low strength-movement-time improvement relationships. Since strength is a component of power by physiological definition these insignificant differences parallel those of the power tests

already discussed.

It is possible that the strength-sprint relationship being observed in this study and others supports the current theory of neuromotor specificity (1, 3, 4, 36, 68, 71) with respect to all forms of motor coordinations. If this in fact is the observation, physiologists must search for new designs of measuring strength which is more related to the sprinting action itself. Perhaps some means of measuring the forces (strength in sprint action) against the ground during an actual sprint is needed to demonstrate strength-100 meter sprint performance.

Since strength is a component of power and since these two measures have been related to 100 meter performance, (Tables VI & VII), it is obvious that a high level of specific strength is necessary for optimal sprint performance.

Analysis of covariance revealed no statistically significant difference in reaction time between groups at post-test time. Single sample T-tests did determine a significant difference in pre minus post values within groups for the control and track groups. These differences denoted a slowing of reaction time, (Table I). The treadmill group experienced a low mean improvement in reaction time but this was not statistically significant. Seventeen of the twenty six studies reviewed in the literature indicated that reaction time is a complex integration of neuro-muscular design and cannot be easily related to movement performance. The results of this study regarding reaction time do not aid in our

understanding of this parameter. These results would therefore agree with Henry when he stated (33) that:

> ". . . the postulation of a common mechanism for reaction time -- movement time, vaguely described as 'speed,' suggests a prediction in which the fundamental reaction time-movement time correlations should be high. In contrast, there are separate neurophysiological mechanisms for movement speed and for reaction speed; muscular force causes speed of limb movement, whereas reaction latency reflects the time required for pre-movement operation of a central nervous system programming-switching mechanism. These concepts lead to the prediction that the fundamental reaction time-movement time correlation should approach zero."

In summarizing what happened during the seven-week study it was found that 100 meter sprint performance improved significantly in all three groups. A significant amount of concentric leg strength was lost in the treadmill group. The track and treadmill group experienced more stress sensations in leg muscles than the control group, the treadmill group experiencing the most. The stress sensations differed significantly between the three groups. These stress sensations could possibly explain the concentric leg strength loss and both in turn could explain why no statistically significant inter-group differences were demonstrated in 100 meter performance.

An analysis of the post-training correlation coefficients, (Table VII), reveals that hip extension and isometric leg strength

lost their relationship with 100 meter performance. Again, the importance of leg power and hip flexion for sprinters was evident.

The fact that large inter and intra variance occurred makes it difficult to find statistical significance. However the general pattern that was observed in the statistical analysis, the heterogeneous findings in the review of literature and the complex relationships that exist between the parameters under study still permitted this investigator to demonstrate a safe method of improving 100 meter sprint performance. Although the improvement was not significantly better than the improvements experienced by the control and flat track training groups, the improvement was more consistent, greater and significant practically in as much as sprint improvements can be stimulated by conventional methods of training. The trend of greatest improvement was toward the direction of the experimental treadmill group despite the fact that to begin with this group displayed the fastest mean 100 meter sprint time (Table I). The pattern that has emerged has intrigued this investigator to pursue further research regarding this sprint training method.

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CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to train subjects on a high speed treadmill and thereby improve their 100 meter sprint time. One subproblem was to compare high speed treadmill training with the conventional method of interval sprint training on a flat track. A second subproblem was to determine the effects of the two sprint training methods upon leg strength, hip flexibility, reaction time, and leg power.

A sample of twenty-four male subjects were utilized. Each subject was ranked at pre-test according to 100 meter sprint time (overage time of four trials) and randomly blocked into one of three groups; control, track training and high-speed treadmill training.

Each subject was tested before and after a seven-week training period. In addition to the 100 meter sprint tests the following standardized tests were administered: maximum oxygen uptake, Sargeant Jump, standing long jump, hip flexion, hip extension, concentric, eccentric and isometric leg strength and reaction time. Anthropometric data from each subject was also recorded in pre and post- test periods. A daily record of subjective muscle-joint complaints was kept.

During the seven-week training period the control group was instructed to continue with their everyday activities as normal.

During this period the track training group trained on a flat track. The high-speed treadmill group trained similiarly on a treadmill. Both training groups performed seven interval sprints six days per week.

An analysis of covariance on each of the dependent variables to see if any significant differences between groups occurred at post-test time resulted in no significance being evident. Correlation coefficients with values of pre-test, post-test and pre and post test differences demonstrated statistically significant correlations between 100 meter performance, Sargent Jump, standing long jump, hip flexion, hip extension and the three measures of strength. Reaction time did not display significant correlation coefficients. Leg strength, leg power and hip flexibility correlation coefficients verified the importance of these parameters when training for 100 meter sprint performance.

Multiple stepwise regression analysis to determine which physiological parameters paralleled 100 meter sprint time improvements (negative or positive) also indicated statistically insignificant coefficients.

Single sample t-tests were computed to determine if any post minus pre differences occurred within groups. Statistically significant differences were observed in 100 meter sprint improvement in all groups, concentric leg strength decrease in the treadmill group and the control and track training groups experienced significant reaction time decreases.

Overload sprint training did improve 100 meter sprint time by a mean difference of .317503 seconds. This improvement was greater than that of the control and track training groups who experienced mean gains of .127505 and .182501 seconds respectively. The mean difference between groups was not statistically significance Of all the parameters under observation the difference between groups in the 100 meter time was nearest to statistical significan (Table II). These findings agreed with many previous studies (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23) which found insignificant differences between power, flexibility, strength, reaction time and sprinting performance after training.

Previous to the study all subjects had participated in some form of physical training as evidenced by the maximum oxygen uptake pre-test mean of 54.92 ml/kg/min., (Appendix A). During the seven-week training period the control, track and treadmill groups experienced 3, 10 and 32 injuries respectively (Table V). No doubt this number of complaints meant that physiological stress was being experienced and this continued in the high-speed treadmill group throughout the seven-week training period.

Conclusions

From the results of this study, the following conclusions were drawn:

(1) Overload sprint training did improve 100 meter sprint time. The mean difference of improvement was

statistically significant at the 0.05 level.

(2) High-speed treadmill training did not result in a statistically significant difference of improvement in 100 meter sprint performance as compared to training on a flat track and a control group.

(3) No statistically significant difference occurred in the eight physiological parameters between the three groups after training.

(4) There is no statistically significant difference in the eight physiological parameters as a result of overload sprint training.

Recommendations

It is recommended that the effects of high-speed treadmill training be studied over a longer period of time to allow for complete physiological adaptation to occur. It is also recommended that this training program should alternate daily with flat track running.

Further research comparing track and high-speed treadmill training should be attempted using sprinters who have reached a performance plateau and have not been able to improve their sprinting ability following conventional training programs. It is also recommended that high speed treadmill training should be utilized as a sprint training method under close supervision.

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APPENDIX A

RAW DATA

SARGEANT VERTICAL JUMP

Subjects	Pre-Trials						Post Trials					
Control	1	2	3	Best	Reach	Jumped Height (inches)	1	2	3	Best	Jumped Height (inches)	Difference in inches
1	8'8"	8'8"	8'10"	8'10"	7'3"	19.0	8'8"	8'10"	8'8"	8'10"	19.0	0.0
2	9'4"	9'6"	9'7"	9'7"	7'10"	19.0	9'7"	9'8"	9'8"	9'8"	20.0	+1.0
3	9'7"	9'7"	9'6"	9'7"	7'7.5"	23.5	9'6"	9'5"	9'6.5"	9'6.5"	23.0	-0.5
4	9'6"	9'7.5"	9'7"	9'7.5"	7'4"	27.5	9'6"	9'7"	9'6"	9'7"	27.0	-0.5
5	8'8"	8'8"	8'9"	8'9"	7'3.5"	17.5	8'8"	8'8"	8'9"	8'9"	17.5	0.0
6	8'9"	8'8.5"	8'9"	8'9"	7'6"	15.0	8'9"	8'9.5"	8'10"	8'10"	16.0	+1.0
7	9'0"	9'1"	9'3"	9'3"	7'4"	23.0	8'11"	9'2"	9'2"	9'2"	22.0	-1.0
8	9'0"	9'1"	9'3"	9'3"	7'10"	17.0	9'3"	9'5"	9'4"	9'5"	19.0	+2.0
Track												
1	9'7"	9'7"	9'6"	9'7"	8'0"	19.0	9'8"	9'8.5"	9'7.5"	9'8.5"	20.5	+1.5
2	9'4"	9'5"	9'6"	9'6"	8'2"	16.0	9'2"	9'4"	9'4.5"	9'4.5"	14.5	-1.5
3	9'3"	9'4"	9'5"	9'5"	7'10"	19.0	9'6"	9'6.5"	9'6"	9'6"	20.0	+1.0
4	9'5"	9'4"	9'5"	9'5"	7'11"	18.0	9'2.5"	9'5.5"	9'6.75"	9'6.75"	19.75	+1.75
5	9'3"	9'3"	9'45"	9'45"	7'7"	21.5	9'4"	9'4"	9'5"	9'5"	22.0	+0.5
6	8'9"	8'9"	8'10"	8'10"	7'3"	19.0	8'8"	8'8"	8'9"	8'9"	18.0	-1.0
7	10'0"	10'3"	10'35"	10'35"	8'3"	24.5	10'2"	10'3"	10'2"	10'3"	24.0	-0.5
8	9'7"	9'7.5"	9'8"	9'8"	8'	20.0	9'7"	9'7.5"	9'9"	9'9"	21.0	+1.0
Treadmill												
1	9'25"	9'35"	9'35"	9'35"	7'10"	17.5	9'3"	9'35"	9'3"	9'35"	17.5	0.0
2	8'10"	8'10"	9'	9'	7'9"	15.0	9'	9'.5"	9'.75"	9'.75"	15.75	+0.75
3	9'6"	9'7"	9'6"	9'7"	7'10"	23.0	9'7"	9'7"	9'6.5"	9'7"	23.0	0.0
4	8'9"	8'11.5"	9'	9'	7'5"	19.0	9'	9'.5"	8'11"	9'.5"	19.5	+0.5
5	8'9"	8'10.5"	8'11.5"	8'11.5"	7'6"	17.5	8'11"	8'11.5"	8'11.5"	8'11.5"	17.5	0.0
6	9'2"	9'3"	9'3"	9'3"	7'6.25"	20.75	9'3.5"	9'3.5"	9'3.5"	9'3.75"	21.5	+0.75
7	9'7"	9'8"	9'6"	9'8"	7'6"	26.0	9'4"	9'6"	9'7"	9'7"	25.0	-1.0
8	8'11"	8'9"	9'	9'	7'6.25"	17.75	9'	8'10.5"	9'.75"	9'.75"	18.5	+0.75

STANDING LONG JUMP

Subjects	Pre				Post				
Control Group	1	2	3	Best	1	2	3	Best	Inches Difference
1	7'7"	7'10"	7'9"	7'10"	7'2"	7'8"	7'10"	7'10"	0.0
2	8'1"	8'	7'10"	8'1"	8'4"	8'1"	8'2"	8'2"	+3.0
3	7'10"	8'3"	8'5.5"	8'5.5"	8'1"	8'6"	8'7"	8'7"	+1.5
4	8'11.5"	8'11"	9'	9'	9'1"	8'11"	8'10"	9'1"	+1.0
5	6'	6'4"	7'	7'	6'	6'7"	6'10.5"	6'10.5"	-1.5
6	5'11"	6'6"	6'10"	6'10"	6'6"	6'7"	6'10"	6'10"	0.0
7	8'	8'2.5"	8'6"	8'6"	8'4"	8'5"	8'5"	8'5"	-1.0
8	7'	7'2"	7'3"	7'3"	7'6"	7'4"	7'5"	7'6"	+3.0
Track									
1	7'11"	8'6"	8'6"	8'6"	7'11"	8'5.5"	7'11"	8'5.5"	-0.5
2	7'6"	7'6.5"	7'3"	7'6.5"	6'6.5"	7'1"	6'11.5"	7'1"	-5.5
3	7'1.5"	7'7.5"	7'9"	7'9"	6'10"	7'8"	7'4"	7'8"	-1.0
4	6'7"	6'9.5"	7'.5"	7'.5"	6'5.5"	6'10.5"	6'7"	6'10.5"	-2.0
5	7'8.5"	7'8"	7'5"	7'8.5"	7'8.5"	7'9"	7'7"	7'9"	+0.5
6	6'3"	5'10.5"	5'9"	6'3"	6'	6'6"	6'6"	6'6"	+3.0
7	7'4.5"	7'2.5"	7'7"	7'7.5"	7'7"	7'6"	8'	8'	+5.0
8	7'6.5"	7'3"	6'9"	7'6.5"	7'1.5"	7'1"	7'	7'1.5"	-5.0
Treadmill									
1	6'8"	6'5"	6'4"	6'8"	6'4"	6'10"	6'6"	6'10"	+2.0
2	6'1.5"	6'3.5"	6'.5"	6'3.5"	5'11"	5'10"	5'11"	5'11"	-4.5
3	7'6"	8'1"	7'11"	8'1"	7'9"	8'4"	8'7"	8'7"	+6.0
4	6'5"	6'10"	7'1"	7'1"	6'11"	7'5"	7'6"	7'6"	+5.0
5	5'10"	5'8"	5'9"	5'10"	5'10.5"	5'11.5"	5'9"	5'11.5"	+1.5
6	7'2"	7'10"	8'4"	8'4"	7'8.5"	8'2.5"	8'4.5"	8'4.5"	+0.5
7	9'7.5"	9'4"	9'3"	9'4"	8'8"	8'9"	8'1"	8'10"	-6.0
8	6'10"	7'	7'2"	7'2"	7'.5"	6'11"	6'9"	7'.5"	-1.5

100 METER TIMES

	Pre-Test (Seconds)					Post-Test (Seconds)					Pre-Post
	T_1	T_2	T_3	T_4	Ave.	T_1	T_2	T_3	T_4	Ave.	Diff.
Control											
1	14.2	13.5	14.6	13.85	14.03	14.0	13.7	14.1	13.5	13.82	-00.21
2	12.9	12.9	13.1	13.0	12.97	12.6	13.0	12.5	12.6	12.67	-00.30
3	13.4	13.5	13.35	13.35	13.40	13.2	13.7	13.1	13.25	13.31	-00.09
4	11.4	11.2	11.1	11.5	11.26	11.0	11.1	10.9	11.1	11.09	-00.17
5	14.1	14.0	13.9	13.4	13.86	13.9	13.5	13.5	13.5	13.60	-00.25
6	12.8	12.7	12.75	13.25	12.87	12.6	13.2	12.9	13.2	12.97	+00.10
7	12.6	12.3	12.1	12.1	12.27	12.7	12.4	12.3	12.1	12.37	+00.10
8	13.5	13.5	13.3	13.1	13.35	12.8	13.0	13.4	13.4	13.15	-00.20
Track											
1	11.9	12.4	12.25	12.1	12.16	12.1	12.2	12.3	12.45	12.26	+00.10
2	14.5	14.6	14.4	14.0	14.37	13.7	14.5	14.5	14.3	14.25	-00.12
3	13.0	13.5	13.45	13.75	13.42	13.0	13.0	12.9	13.0	12.97	-00.75
4	13.1	13.0	12.8	13.0	12.97	12.1	12.3	12.5	12.9	12.45	-00.52
5	12.0	11.5	11.9	11.4	11.70	11.1	11.5	11.5	11.4	11.39	-00.31
6	13.9	14.2	15.2	13.5	14.20	14.7	14.5	14.2	13.95	14.33	+00.13
7	11.9	11.85	12.1	12.1	11.98	11.7	11.7	11.7	11.8	11.70	-00.28
8	12.8	11.9	11.7	11.5	11.97	12.0	12.0	11.9	12.0	11.97	00.00
Treadmill											
1	12.3	12.6	12.5	12.5	12.48	12.2	12.0	12.0	12.4	12.15	-00.33
2	12.4	12.5	12.5	12.8	12.50	12.35	12.4	12.1	12.2	12.26	-00.24
3	11.2	11.5	11.6	11.7	11.57	11.3	11.8	11.6	11.6	11.57	00.00
4	12.2	12.1	11.9	11.8	12.00	12.2	11.8	11.7	11.9	11.90	-00.10
5	13.4	13.7	13.8	12.8	13.67	12.75	12.8	12.9	12.8	12.81	-00.86
6	12.3	12.8	12.5	12.7	12.58	12.7	12.4	12.8	12.7	12.65	+00.07
7	12.9	12.4	12.4	12.3	12.50	12.2	12.1	12.3	12.1	12.18	-00.32
8	14.5	13.8	13.8	13.6	13.92	13.1	13.2	13.15	13.2	13.16	-00.76

HIP FLEXIBILITY (Degrees)

Control Group	Flexion Pre °	Flexion Post °	Flexion Degrees Difference °	Extension Pre °	Extension Post °	Extension Degrees Difference °
1	76	85	+9	28	37	+9
2	104	90	-14	20	32	+12
3	105	118	+13	35	36	+1
4	110	115	+5	31	42	+11
5	80	85	+5	40	36	-4
6	70	65	-5	26	25	-1
7	95	98	+3	42	38	-4
8	110	105	-5	27	24	-3
Track						
1	102	95	-7	32	25	-7
2	95	102	+7	32	41	+9
3	90	85	-5	30	28	-2
4	80	85	+5	30	32	+2
5	110	105	-5	57	53	-4
6	65	45	-20	35	35	0
7	114	120	+6	30	44	+14
8	89	90	+1	30	33	+3
Treadmill						
1	105	110	+5	25	34	+9
2	85	82	-3	35	31	-4
3	85	90	+5	22	30	+8
4	130	116	-14	40	37	-3
5	75	61	-14	31	21	-10
6	114	120	+6	37	48	+11
7	117	114	-3	35	40	+5
8	85	75	-10	29	30	+1

LEG STRENGTH

CONCENTRIC (lbs.)

	Pre			Post			Pre Post
Control	1	2	Best	1	2	Best	Diff.
1	1110	1020	1110	1145	995	1145	+35
2	1070	820	1080	860	1050	1050	-30
3	1040	1160	1160	1095	950	1095	-65
4	1220	1460	1460			930	-530
5	650	940	940	600	1170	1170	+230
6	1090	540	1090	800	940	940	-150
7	480	580	580	420	560	560	-20
8	650	440	650	385	810	810	+160
Track							
1	1310	1200	1310	980	1140	1140	-170
2	420	560	560	420	520	520	-40
3	570	460	570	570	660	660	+90
4	360	460	460	220	290	290	-170
5	560	800	800	320	440	440	-360
6	690	640	690	260	480	480	-210
7	370	640	640	980	990	990	+350
8	1130	1100	1130	1230	1275	1275	+145
Treadmill							
1	780	1120	1120	600	710	710	-410
2	460	510	510	260	445	445	-65
3	640	680	680	800	690	800	+120
4	280	560	560	450	330	450	-110
5	370	380	380	320	420	420	+40
6	1130	1380	1380	570	880	880	-500
7	1240	1400	1400	850	980	980	-420
8	870	1200	1200	610	750	750	-450

LEG STRENGTH

ECCENTRIC (lbs.)

	Pre			Post			Pre Minus Post
Control	1	2	Best	1	2	Best	Diff.
1	1480	1180	1480	1430	1410	1430	-50
2	1060	980	1060	1230	1250	1250	+190
3	1180	1340	1340	1445	1305	1445	+105
4	1150	1360	1360			1020	-340
5	1050	1060	1060	1210	1215	1215	+155
6	1410	1440	1440	1360	1510	1510	+70
7	700	700	700	720	800	800	+40
8	720	820	820	785	910	910	+40
Track							
1	1530	1520	1530	1350	1280	1350	-200
2	480	440	480	685	970	970	+490
3	760	830	830	985	1040	1040	+210
4	420	480	480	320	400	400	-80
5	1010	1060	1060	1140	1295	1295	+235
6	1540	1380	1540	520	540	540	-1000
7	1160	1410	1410	1360	1460	1460	+50
8	1560	1550	1560	1465	1460	1460	-100
Treadmill							
1	740	730	740	440	600	600	-140
2	610	620	620	495	695	695	+75
3	1130	860	1130	1440	1570	1570	+440
4	680	950	950	730	650	730	-220
5	1060	1040	1060	670	640	670	-390
6	1200	1440	1440	1370	1460	1460	+20
7	1300	1420	1420	1360	1270	1360	-60
8	1530	1540	1540	1440	1380	1440	-100

LEG STRENGTH

ISOMETRIC (lbs.)

	Pre			Post			Pre Post
Control	1	2	Best	1	2	Best	Diff.
1	570	520	570	1110	1005	1110	+540
2	995	985	995	1280	1240	1280	+285
3	1250	1400	1440	1335	1225	1335	-65
4	1070	740	1070			1000	-70
5	1320	1390	1390	1210	1210	1210	-180
6	630	710	710	830	850	850	+140
7	620	640	640	720	740	740	+100
8	630	700	700	840	980	980	+280
Track							
1	1540	1540	1540	1340	1370	1370	-170
2	400	500	500	545	445	545	+45
3	500	540	540	600	730	730	+190
4	420	520	520	330	350	350	-170
5	730	850	850	1100	1160	1160	+310
6	780	1050	1050	380	410	410	-640
7	1090	1030	1090	1200	1200	1200	+110
8	1550	1310	1550	1465	1465	1465	-85
Treadmill							
1	1140	1120	1140	740	800	800	-340
2	440	620	620	445	445	445	-175
3	900	1060	1060	1230	1410	1410	+350
4	660	680	680	600	630	630	-50
5	690	600	690	480	460	480	-210
6	1170	1190	1190	1120	1140	1140	-50
7	1160	1150	1160	1140	1110	1110	-50
8	1050	1060	1060	810	820	820	-240

MAXIMUM O_2 UPTAKE

Control Group	Pre ml/kg.	Post ml/kg	Difference ml/kg/min	Body Weight lbs. Pre Wt. (lbs.)	Post Wt. (lbs.)	Pre-Post Differences
1	49.05	46.73	-2.32	150	150	+3.5
2	51.87	49.53	-2.34	165	166	+1.0
3	50.97	49.42	-1.55	165	162	-3.0
4	56.85	55.37	-1.48	145	145.5	+0.5
5	48.54	45.70	-2.84	155	152	-3.0
6	59.26	63.39	+4.13	135	137.5	+2.5
7	52.17	51.8	-0.37	148	149	-3.7
8	63.36	57.14	-6.22	164	166	-6.22
Track						
1	56.21	57.35	+1.14	197	192	-5.0
2	61.32	59.20	-2.12	178	183	+5.0
3	57.50	57.8	+0.30	166	164	-1.0
4	45.78	52.22	+6.44	141	137	-4.0
5	60.20	58.77	-1.43	133	135	+2.0
6	58.19	58.15	-0.04	148	150.5	+2.5
7	49.03	60.69	+11.66	185	186.5	+1.5
8	51.21	50.98	-0.23	196	189.5	-6.5
Treadmill						
1	55.38	54.12	-1.26	168.5	166	-2.5
2	58.28	56.64	-1.64	147	144	-3.0
3	55.78	56.81	+1.03	173	176	+3.0
4	49.11	53.04	+3.93	127.5	128	+0.5
5	49.60	53.48	+3.88	150	149	-1.0
6	66.36	67.40	+1.04	139.5	140	+1.04
7	55.11	55.72	+0.61	152	150	-2.0
8	55.93	60.86	+4.93	152	157	+5.0

Pre test MV O_2 Mean = 54.92 ml/kg/min.
Post test MV O_2 Mean = 55.36 " " "

Post-test Reaction Time (seconds)

	Post Internal					Ave.	Post External					Ave.	Sum of Ave.	Difference in sum of ave
Control														
1	.33	.34	.32	.39	.27	.330	.05	.04	.03	.03	.02	.033	.363	+.147
2	.21	.30	.24	.34	.32	.283	.05	.02	.02	.01	.01	.017	.300	+.070
3	.33	.26	.22	.23	.23	.240	.02	.02	.02	.02	.03	.020	.260	+.030
4	.26	.39	.32	.27	.26	.283	.01	.02	.03	.03	.02	.023	.306	+.072
5	.35	.29	.25	.26	.28	.273	.01	.02	.01	.04	.05	.023	.296	+.002
6	.21	.18	.21	.20	.27	.206	.01	.03	.02	.02	.01	.013	.219	-.051
7	.22	.30	.24	.34	.32	.286	.03	.04	.02	.03	.02	.026	.312	-.018
8	.34	.37	.27	.38	.29	.333	.02	.05	.02	.02	.00	.020	.353	+.070
Track														
1	.24	.21	.22	.24	.18	.223	.02	.01	.01	.00	.01	.010	.243	+.060
2	.23	.27	.19	.24	.19	.220	.05	.06	.06	.04	.06	.056	.276	+.096
3	.22	.22	.40	.20	.21	.216	.02	.02	.03	.06	.01	.023	.239	+.052
4	.21	.36	.31	.26	.28	.283	.01	.03	.03	.02	.04	.026	.309	+.122
5	.22	.25	.28	.27	.26	.260	.03	.04	.04	.01	.06	.043	.303	+.070
6	.21	.23	.24	.19	.19	.210	.03	.03	.02	.03	.03	.030	.240	+.057
7	.23	.23	.28	.22	.22	.223	.05	.02	.02	.04	.03	.030	.253	-.037
8	.17	.22	.17	.21	.20	.193	.02	.00	.03	.03	.03	.026	.219	-.028
Treadmill														
1	.26	.26	.22	.27	.27	.263	.01	.00	.02	.00	.01	.006	.269	-.017
2	.24	.21	.22	.26	.22	.226	.01	.01	.04	.01	.02	.013	.239	+.028
3	.26	.25	.21	.23	.22	.233	.00	.00	.02	.01	.02	.010	.243	-.010
4	.24	.30	.30	.27	.25	.273	.00	.03	.07	.04	.03	.033	.306	+.067
5	.19	.20	.16	.18	.13	.177	.06	.03	.02	.04	.04	.033	.210	-.053
6	.23	.24	.26	.23	.26	.243	.01	.01	.00	.00	.02	.013	.256	-.037
7	.23	.20	.21	.20	.21	.206	.02	.03	.05	.06	.03	.036	.242	+.025
8	.27	.38	.40	.23	.21	.260	.04	.03	.05	.02	.06	.040	.300	-.020

Pre-test Reaction Time

	PreInternal					Ave.	PreExternal					Ave.	Sum of Ave.
Control													
1	.17	.12	.17	.19	.12	.153	.08	.07	.06	.05	.06	.063	.216
2	.25	.22	.22	.25	.19	.210	.03	.02	.02	.02	.02	.020	.230
3	.19	.14	.15	.11	.21	.160	.05	.08	.07	.08	.06	.070	.230
4	.17	.19	.17	.21	.18	.187	.06	.04	.04	.05	.05	.047	.234
5	.27	.27	.22	.21	.25	.247	.05	.05	.03	.05	.04	.047	.294
6	.22	.22	.21	.32	.25	.230	.04	.04	.04	.04	.03	.040	.270
7	.18	.21	.21	.22	.20	.207	.04	.02	.03	.02	.03	.023	.230
8	.18	.23	.18	.22	.27	.210	.08	.07	.08	.06	.07	.073	.283
Track													
1	.13	.13	.15	.15	.14	.140	.04	.04	.05	.04	.05	.043	.183
2	.14	.13	.16	.12	.14	.137	.04	.04	.05	.05	.05	.043	.180
3	.20	.15	.15	.19	.15	.165	.02	.01	.03	.01	.02	.022	.187
4	.16	.17	.14	.15	.20	.160	.02	.03	.02	.03	.03	.027	.187
5	.19	.22	.16	.15	.25	.190	.03	.03	.04	.04	.03	.033	.222
6	.10	.10	.19	.13	.22	.140	.04	.05	.04	.05	.04	.043	.183
7	.25	.37	.25	.23	.25	.250	.06	.01	.03	.06	.03	.040	.290
8	.21	.22	.21	.22	.21	.220	.03	.03	.02	.02	.03	.027	.247
Treadmill													
1	.28	.28	.27	.27	.24	.273	.01	.01	.02	.01	.02	.013	.286
2	.20	.16	.22	.20	.22	.201	.01	.02	.01	.01	.01	.010	.211
3	.21	.18	.22	.19	.21	.203	.04	.05	.05	.05	.05	.050	.253
4	.22	.22	.26	.20	.13	.213	.02	.06	.02	.02	.04	.026	.239
5	.27	.25	.24	.27	.24	.253	.00	.00	.01	.02	.03	.010	.263
6	.26	.43	.23	.25	.28	.263	.05	.03	.03	.03	.03	.030	.293
7	.19	.18	.16	.18	.17	.177	.02	.03	.05	.06	.04	.040	.217
8	.25	.36	.26	.21	.32	.277	.06	.02	.03	.04	.06	.043	.320

Comparison of Fast and Slow Sprinters (Pre Scores Ranked)

Subjects	100 M. Times Pre	Post	Pre Max O_2	Height Rank Shortest 1st	Pre Age Rank Oldest 1st	Pre Body Weight Rank Lightest 1st	Pre Hip Flex Rank Best 1st
FAST							
1	11.1	10.9	9	3	18	7	7
2	11.4	11.1	4	19	18	2	7
3	11.5	11.3	12	17	13	24	23
4	11.5	11.9	17	19	1	28	22
5	11.6	11.1		9	26	3	2
6	11.8	11.7	20	9	26	1	1
7	11.85	11.7	22	24	9	27	4
8	11.9	12.1	10	24	2	29	15
9	12.1	12.1	15	2	16	10	19
10	12.3	12.1	14	12	18	14	3
11	12.3	12.4	1	12	23	12	4
12	12.3			24	9	23	13
13	12.3	12.0	13	21	5	20	11
14	12.4	12.1	7	18	6	8	23
slower			144	213 tallest	190 oldest	208 heaviest	154
1	12.7	12.6	5	4	6	4	30
2	12.8	12.75	19	15	9	12	29
3	12.8	12.1	24	21	18	6	26
4	12.9	12.5	16	21	13	22	13
5	13.0	12.9	8	24	6	20	21
6	13.0			12	18	12	17
7	13.1	12.8	2	21	16	18	7
8	13.2			4	23	9	16
9	13.4	13.1	18	9	23	19	11
10	13.4	13.5	23	1	4	16	26
11	13.5	13.5	21	4	9	12	28
12	13.5	13.95	6	2	28	10	31
13	13.6	13.1	11	8	28	14	23
14	14.0	13.7	3	28	3	26	18
			156	174	204 youngest	200 lightest	296 least flexion

Pre Hip Extension Rank	Pre SVJ Rank best 1st	Pre Rx. time pre rank (1st in slowest)	Pre Con leg Str. Rank	Pre Ecc. Str. Rank	Pre Iso. Leg Str. Rank
17	1	15	1	11	12
1	8	11	15	17	19
29	5	19	19	15	15
19	11	18	8	1	1
4	12	6	28	26	24
4	12	16	24	21	22
19	3	26	4	10	11
15	12	2	4	5	2
3	5	12	22	26	23
10	2	10	2	9	8
9	10	27	3	7	7
2	7		26	16	14
28	22	25	9	25	9
10	28	8	27	29	25
170	138	195	209	218	192
27	28	21	12	7	20
17	22	20	30	17	26
19	19	4	29	30	29
31	12	12	13	17	17
19	12	4	23	23	28
4	8		17	22	18
26	25	24	20	24	21
8	25		31		26
10	4	12	7	28	21
4	22	29	14	13	4
25	12	9	10	17	27
10	12	2	18	6	13
24	21	27	6	2	16
15	27	1	24	30	30
239	249	165	254	236	296
least extension	least	fastest	weakest	weakest	weakest

Subjects	Pre SLJ	Pre Stride Length	Pre Stride Rate	
Fast				
1	2			
2	15	5	7	
3	10			
4	17	12	4	
5	12			
6	22	7	13	Comparing Fast and Slow Runners
7	16	3	16	(Pre test Ran Order)
8	4	1	20	
9	4	15	15	(Shortest, Oldest,
10	1	9	12	lightest, fastest,
11	6	2	19	most flexible,
12	3			strongest, longest,
13	27	11	14	and best performance
14	30	10	8	is ranked first)
Slow	169	75	118	
1	25	4	15	
2	31	14	11	
3	23	6	18	
4	10	20	3	
5	14	13	9	
6	19			
7	20			
8	26			
9	5	19	2	
10	24	21	11	
11	12	18	6	
12	29			
13	21	17	10	
14	17	16	17	
	276	148	92	
	least	shortest	faster rate	

Comparison of Fast and Slow Sprinters - Post Scores Ranked

(Best or Fastest is Ranked First) (Training Groups Only)

Training Group Subjects	SLJ	SVJ	RT	CLS	ELS	ILS	HF	HE	SR	SL
FAST										
1	15	4	14	14	8	5	6	1	2	4
2	2	3	7	6	1	2	9	12		
3	9	6	2	1	2	1	9	9	1	8
4	8	10	15	12	9	11	3	6	11	2
5	5	2	8	3	2	4	1	3	10	1
6	3	7	7	2	7	3	8	15	14	3
7	1	1	6	4	6	7	4	5	3	9
8	4	5	9	5	2	6	1	2	7	6
	47	38	68	47	37	39	41	53	48	33
SLOWER										
1	12	13	10	8	14	9	5	8	8	7
2	16	15	3	13	12	13	13	11	4	10
3	15	13	1	15	13	14	15	16	9	11
4	13	9	16	16	16	16	11	10	6	14
5	7	8	3	9	7	10	11	14	12	5
6	14	12	5	11	15	15	16	7		
7	11	11	13	7	5	8	14	12	5	13
8	10	16	12	10	10	12	7	4	13	12
	98 weaker	97 weaker	63 faster	89 weaker	92 weaker	97 weaker	92 less flexion	82 less extension	49 same	72 shortest stride length

Comparing Fast and Slow Sprinters

Post Minus Pre Values - Training Group Subjects

Training Group Subjects	100 m	SVJ	SLJ	HF	HE	CLS	ELS	ILS	RT
FAST									
1	-.31	.50	.50	-5	-4	-360	235	310	.040
2	0	0	6	5	8	120	440	350	-.005
3	0	1.0	-5	1	3	145	-100	-85	-.014
4	-.10	.5	5	-14	-3	-110	-220	-50	.034
5	-.28	-.5	5	6	14	350	50	110	-.019
6	.11	1.5	-.5	-7	-7	-170	-200	-170	.013
7	-.32	-1	-6	-3	5	-420	-60	-50	.013
8	.07	.75	.5	-6	11	-500	20	-50	-.018
	.90	2.75	17.5	-12	27	-945	165	365	.057
SLOWER									
1	-.33	0	2	5	9	-410	-140	-340	-.009
2	-.24	.75	-4.5	-3	-4	- 65	75	-175	.014
3	-.86	0	1.5	-14	-10	40	-390	-210	-.026
4	-.52	1.75	-2	5	2	-170	- 80	-170	.061
5	-.75	1.0	-1	-5	-2	90	210	190	.026
6	.13	-1.0	3	-20	0	-210	-1000	-640	.029
7	.76	.75	-1.5	-10	1	-450	-100	-240	-.010
8	-.14	-1.5	-5.5	7	9	- 40	490	45	.048
	-3.3	1.75	-8	-35	5	-1215	-925	-1540	.133

POST -- PRE DIFFERENCES

SUBJECT	SVJ inches	SLJ inches	100 m seconds	HF degrees	HE degrees	CLS pounds	ELS pounds	ILS pounds	RT seconds
Control									
1	0	0	-.21	9	9	35	-50	540	.073
2	1	3	-.30	-14	12	-30	190	285	.035
3	-.5	1.5	-.09	13	1	-65	105	-65	.015
4	-.5	1	-.17	5	11	530	-340	-70	.036
5	0	-1.5	-.25	5	-4	230	155	-180	.001
6	1	0	.10	-5	-1	-150	70	140	-.026
7	-1	-1	.10	3	-4	-20	40	100	.041
8	2	3	-.20	-5	-3	160	90	280	.035
Ave. Dif.	.25	.75	-.127 improvement	1.37	2.62	86.25	32.50	128.75	.02625
Track									
1	1.5	- .5	.11	-7	-7	-170	-200	-170	.031
2	-1.5	-5.5	-.14	7	9	-40	490	45	.048
3	1.0	-1.0	-.75	-5	-2	90	210	190	.026
4	1.75	-2.0	-.52	5	2	-170	-80	-170	.061
5	.50	.50	-.31	-5	-4	-360	235	310	.040
6	-1.0	3.0	.13	-20	0	-210	-1000	-640	.029
7	-.50	5.0	-.28	6	14	350	50	110	-.019
8	1.0	-5.0	.00	1	3	145	-100	-85	-.014
Ave. Dif.	.34375	.6875	-.1575 improvement	2.25	1.875	-45.625	-49.375	-51.25	.02525
Treadmill									
1	0	2	-.33	5	9	-410	-140	-340	-.009
2	.75	-4.5	-.24	-3	-4	-65	75	-175	.014
3	0	6	.00	5	8	120	440	350	-.005
4	.5	5	-.10	-14	-3	-110	-220	-50	.034
5	0	1.5	-.86	-14	-10	40	-390	-210	-.026
6	.75	.5	.07	6	11	-500	20	-50	-.018
7	-1	-6.0	-.32	-3	5	-420	-60	-50	.013
8	.75	-1.5	-.76	-10	1	-450	-100	-240	-.010
	.21875	.375	-.3175 improvement	3.50	2.125	-224.375	-46.875	-95.625	-.000875

Post-Training Test Data Summary

Variable	MEAN	STD. DEV.	MINIMUM	MAXIMUM
SVJ	19.7958	3.31816	15.0000	27.5000
SLJ	90.8333	10.5457	70.0000	112.0000
100M	12.8333	0.893166	11.2600	14.3900
HF	95.4583	16.8471	65.0000	130.0000
HE	32.4583	7.53531	20.0000	57.0000
CLS	894.167	337.871	380.0000	1460.0000
ELS	1127.08	357.243	480.0000	1560.0000
ILS	946.458	328.861	500.0000	1550.0000
RT	0.119458	0.206038E-01	0.900000E-01	0.160000

Pre-Training Test Data Summary

Variable	MEAN	STD. DEV.	MINIMUM	MAXIMUM
SVJ	20.0626	3.02907	14.5000	27.0000
SLJ	90.9792	10.6806	71.0000	109.0000
100M	12.6241	0.855754	11.0900	14.3300
HF	94.0000	19.8253	45.0000	120.0000
HE	34.6667	7.67643	21.0000	53.0000
CLS	788.7500	287.898	290.0000	1275.0000
ELS	1109.17	362.094	400.0000	1570.0000
ILS	940.417	343.189	350.0000	1465.0000
RT	0.136333	0.206668E-01	0.105000	0.181000

APPENDIX B

ANALYSIS OF COVARIANCE SUMMARY AND T-TEST STATISTICAL COMPUTATION FOR EXPERIMENTAL PARAMETERS (PRE AND POST)

ANALYSIS OF COVARIANCE SUMMARY

Adjusted Analysis of Variance - Sargeant Jump

Source	DF	MS	ADJ F	P
GRP	2	0.44807434E-01	0.56782637E-01	0.945
WTH	20	0.78910446E 00		

R SQ= 0.92456090E 00

Adjusted Analysis of Variance - Standing Long Jump

Source	DF	MS	ADJ F	P
GRP	2	0.53304443E 01	0.46158594E 00	0.637
WTH	20	0.11548107E 02		

R SQ= 0.90415514E 00

Adjusted Analysis of Variance - 100 Meter Sprint

Source	DF	MS	ADJ F	P
GRP	2	0.10243511E 00	0.16954298E	0.209
WTH	20	0.60418367E-01		

R SQ= 0.92278510E 00

Adjusted Analysis of Variance - Hip Flexion

Source	DF	MS	ADJ F	P
GRP	2	0.58039063E 02	0.73968238E	0.490
WTH	20	0.78464844E 02		

R SQ= 0.82406491E 00

Adjusted Analysis of Variance - Hip Extension

Source	DF	MS	ADJ F	P
GRP	2	0.13797607E 01	0.32301068E-01	0.968
WTH	20	0.42715637E 02		

R SQ= 0.35291588E 00

Adjusted Analysis of Variance - Concentric Leg Strength

Source	DF	MS	ADJ F	P
GRP	2	0.98057563E 05	0.26585093E 01	0.095
WTH	20	0.36884410E 05		

R SQ= 0.51973045E 00

Adjusted Analysis of Variance - Eccentric Leg Strength

Source	DF	MS	ADJ F	P
GRP	2	0.27862500E 05	0.33781630E	0.717
WTH	20	0.82478250E 05		

R SQ= 0.43545473E 00

Adjusted Analysis of Variance - Isometric Leg Strength

Source	DF	MS	ADJ F	P
GRP	2	0.10821050E 06	0.19078379E 01	0.174
WTH	20	0.56718898E 05		

R SQ= 0.54957259E 00

Adjusted Analysis of Variance - Reaction Time

Source	DF	MS	ADJ F	P
GRP	2	0.11603795E-02	0.31141062E 01	0.066
WTH	20	0.37262030E-03		

R SQ= 0.26081370E-05

T-Test Computation Formula

1 tailed df = 7

$$T = \frac{\bar{X}_1 - \bar{X}_2}{S/\sqrt{n}}$$

where $\bar{X}_1$ and $\bar{X}_2$ are pre and post mean values

Critical T = 1.895

Sargent Jump Single Sample T-Test Calculation

Groups

Control	$\frac{.2500}{.3536} = .707$
Track	$\frac{.3428}{.4250} = .808$
Treadmill	$\frac{.2038}{.2084} = .977$

Standing Long Jump Single Sample T-Test Calculations

Groups

Control	$\frac{.7500}{.5976}$	= 1.2550
Track	$\frac{.6875}{1.2745}$	= .539
Treadmill	$\frac{.3750}{1.4933}$	= .251

100 Meter Sprint Single Sample T-Test Calculations

(pre minus post values)

Groups	
Control	$\frac{.1275}{.0534} = 2.3876^*$
Track	$\frac{.1788}{.0866} = 2.064^*$
Treadmill	$\frac{.3138}{.1178} = 2.6638^*$

*significant at 0.05 level

Hip Flexion Single Sample T-Test Calculations

Groups

Control $\frac{1.38}{3.10} = .445$

Track $\frac{2.25}{3.19} = .705$

Treadmill $\frac{3.50}{2.98} = 1.17$

Hip Extension Single Sample T-Test Calculations

Groups

Control	$\frac{2.63}{2.44} = 1.07$
Track	$\frac{1.88}{2.43} = .773$
Treadmill	$\frac{2.13}{2.61} = .816$

Concentric Leg Strength Single Sample T-Test Calculations

Groups

Control $\frac{46.25}{81.45} = .567$

Track $\frac{45.63}{81.07} = .562$

Treadmill $\frac{224.38}{87.28} = 2.570^{*}$

*significant at 0.05 level

Eccentric Leg Strength Single Sample T-Test Calculations

Groups

Control	$\frac{40.00}{59.68} = .670$
Track	$\frac{46.88}{156.59} = .299$
Treadmill	$\frac{46.88}{86.16} = .544$

Isometric Leg Strength Single Sample T-Test Calculations

Groups	
Control	$\frac{128.75}{83.42} = 1.543$
Track	$\frac{51.25}{103.50} = .495$
Treadmill	$\frac{95.63}{73.77} = 1.296$

Reaction Time Single Sample T-Test Calculations

Groups

Control	$\frac{.2600}{.1044} = 2.490^*$
Track	$\frac{.2525}{.0974} = 2.592$
Treadmill	$\frac{.0088}{.0677} = .129$

*significant at 0.05 level

APPENDIX C

STUDY DROPOUTS

The following is a list of twelve subjects who dropped out of the study.

Subject	100 meter time (average of 4 pre-test trials)	Reason for dropping out.
1.	11.04	- When randomly selected to treadmill group the subject chose to drop out of the study.
2.	12.40	- The subject was forced to drop out due to an ankle injury received during 100 meter pre-test trials.
3.	12.90	- The subject failed to complete the pre-test battery during the two day time limit.
4.	12.00	These subjects did not meet the minimal level of oxygen uptake requirement.
5.	14.20	
6.	13.10	These subjects did not submit to following training instructions.
7.	12.20	
8.	13.40	
9.	12.60	- The subject dropped out due to academic pressures.
10.	16.20	- The subject lost interest in the study.
11.	13.70	- The subject dropped out due to quadriceps muscle injury not related to this study.
12.	12.70	- The subject reported "stiff and sore" at post-test and thus had to be dropped. This stiffness and soreness was due to a camping and hiking holiday which was not normal for his daily activity.